NORTHCENTRAL UNIVERSITY
ASSIGNMENT COVER SHEET

Student: **Michael Higley-Vance**

THIS FORM MUST BE COMPLETELY FILLED IN

Follow these procedures: If requested by your instructor, please include an assignment cover sheet. This will become the first page of your assignment. In addition, your assignment header should include your last name, first initial, course code, dash, and assignment number. This should be left justified, with the page number right justified. For example:

DoeJXXX0000-1	1

Save a copy of your assignments: You may need to re-submit an assignment at your instructor's request. Make sure you save your files in accessible location.

Academic integrity: All work submitted in each course must be your own original work. This includes all assignments, exams, term papers, and other projects required by your instructor. Knowingly submitting another person's work as your own, without properly citing the source of the work, is considered plagiarism. This will result in an unsatisfactory grade for the work submitted or for the entire course. It may also result in academic dismissal from the University.

EDU7006-8 **Dr. Rebecca Watts**

Quantitative Research Design **Activity #4: Express Experimental Designs II**

Comments: Had some trouble describing the interaction effects. The main effects seemed pretty easy to identify and explain. Thanks for the help…

Faculty Use Only

Michael, thanks for your work on this assignment. You are making good progress. I made several comments in your paper. One particular issue that I found in this assignment was your explanation of the significance of main and interaction effects. After you calculate the F-values (and you calculated these correctly), you must look at the critical F-value tables and determine the critical F - values for the .05 and .01 level of significance for the respective degree of freedom. Then you will compare the calculated F to

the critical F to determine significance. I also made a comment in your paper about determining significance. A variable either has a significant effect or no significant effect. There is no such thing as a "little to no" effect. You have to be careful with your wording of the results. Your answers to the questions were sufficient; however, I did provide additional information on some of those question to help with your understanding. Please let me know if you have any questions. I am going to send you two files that may be helpful with activity 5. In that assignment, you study the different research designs. Please let me know if you have any questions.

Summary of Threats to Internal Validity

Score = 90

<Faculty Name> <Grade Earned> <Writing Score> <Date Graded>

Numerical Points	Letter Grade	Descriptor	Explanation
100 - 94	**A**	**Excellent**	Completes **all** required parts of the assignment, demonstrates **deep** understanding of materials, uses **very** clear and effective expression appropriate to scholarly writing, and has **very few or no** errors in grammar, mechanics, and APA formatting.
93-90	**A-**		
89-87	**B+**	**Good**	Completes **all or most** required parts of the assignment, demonstrates **good** understanding of readings, uses **mostly** clear and effective expression appropriate to scholarly writing, and has **few** errors in grammar, mechanics, and APA formatting.
86-83	**B**		
82-80	**B-**	**Fair**	Completes **most** required parts of the assignment, demonstrates **some** understanding of readings, and writing is **somewhat** clear, effective , and scholarly, and has **some** errors in grammar, mechanics, and APA formatting.
79-77	**C+**		
76-73	**C**	**Poor**	Completes **some** required parts of the assignment, demonstrates **some** understanding of readings, and writing is **difficult to understand** and **unscholarly** and has **several** errors in grammar, mechanics, and APA formatting.
72-0	**F**	**Unacceptable**	Completes **few** required parts of the assignment, demonstrates **little** understanding of readings, and writing is **difficult to understand** and **unscholarly** and has **many** errors in grammar, mechanics, and APA formatting.

Express Experimental Designs II

1. Jackson, even-numbered Chapter Exercises, pp. 335-337.

   - Question 2. How many independent variables are in a 4 x 6 factorial design? There are two independent variables. How many conditions (cells) are in this design?

There are four (4) conditions in the first variable and six (6) conditions in the second (Trochim, 2006; Jackson, 2012). So, if you consider every condition on the first variable in regard to every condition on the second variable, there are 24 conditions.

- Question 4. What is the difference between a cell (condition) mean and the means used to interpret a main effect? Main effects are differences in means over levels of one variable distributed over levels of another variable. Interpreting a main effect involves the comparison of marginal means, while a cell mean incorporates the mean of the particular variable and conditions directly related to that variable (Jackson, 2012).

For the sake of simplicity, let's use gender and ethnicity as the two independent variables (I do realize that these variables cannot be manipulated as a treatment) and the dependent variable is SAT score. The main effects are the effect of gender on SAT scores and the effect of ethnicity on SAT score. Thus, we would have two means for the gender main effect (male mean and female mean). We would have two or more means for the ethnicity main effect (White, Asian, Hispanic, African American). The main effects compare the means of these groups for each independent variable independently.

For the interaction effect, we want to know if the SAT scores differ among males and females according to the ethnicity. Thus, we are looking at cell means when explaining interaction effects. If the ANOVA analysis shows a significant interaction effect, this means that the female and male SAT scores differ for the different ethnic groups. Thus, the main effects do not really tell the whole story. So, given the interaction effect is significant, we must now determine if there are significant differences in SAT scores for males among the different ethnic groups. We must also determine if there are significant differences in SAT scores for females among the different ethnic groups. Thus, we must separate the data set into two files, one file that contains only the female cases and a second file that contains only the male cases. Then, we would run one-way ANOVA analyses to determine if SAT scores differ for the different ethnic groups among the males and then among the females.

- Question 6. What is the difference between a complete factorial design and an incomplete factorial design? According to Trochim (2006) a complete factorial design is one in which consists of every possible variable and interaction is implemented and tested. An incomplete factorial design is one in which some variables and combination factors are purposefully left untested.

- Question 8. Explain the difference between a two-way ANOVA and a three-way ANOVA. A two-way ANOVA is a statistical test used to analyze the variance between variables (groups) and within variables. If either of the two variables has an effect, the research can conclude that the variance between the variables is greater than the variance within the variables (Jackson, 2012). A three-way ANOVA is much like the two-way ANOVA but in this case there is a two-way interaction that varies across levels of a third variable (Cohen, n.d.).

A two-way ANOVA indicates there are two independent variables in the study. A three-way ANOVA indicates there are three independent variables in the study (Jackson, 2012).

- Question 10. Complete each of the following ANOVA summary tables. In addition, answer the following questions for each of the ANOVA summary tables.

Source	Df	SS	MS	F
A	1	60	60	8.995
B	2	40	20	2.998
A x B	2	90	45	6.746
Error	30	200	6.67	
TOTAL	35	390		N=36

a. What is the factorial notation? 2 x 3

b. How many conditions were in the study? Six

c. How many subjects were in the study? 36

d. Identify significant main effects and interaction effects. Source A has a larger main effect than does source B. There seems to be a slight interaction effect indicated by the AxB mean squared, 45.

Factor A: $F(1,30) = 9.00$

$F_{cv(.05)} = 4.17$

$F_{cv(.01)} = 7.56$

Because F_{obt} for factor A exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant main effect of factor A.

Factor B: $F(2,30) = 2.999$

$F_{cv(.05)} = 3.32$

$F_{cv(.01)} = 5.39$

Because F_{obt} for factor B is less than both of the values for F_{cv}, it is not significant.

AxB: $F(2,30) = 6.750$

$F_{cv(.05)} = 3.32$

$F_{cv(.01)} = 5.39$

Because F_{obt} for the interaction term (AxB) exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant interaction effect.

~~d.~~

Source	Df	SS	MS	F
A	2	40	20	9.601
B	3	60	20	9.601

A x B	6	150	25	12.001
Error	72	150	2.083	
TOTAL	83	400		N=84

a. What is the factorial notation? 3 x 4

b. How many conditions were in the study? 12

c. How many subjects were in the study? 84

d. Identify significant main effects and interaction effects. There is no significant effect on A or B but together there is an interaction effect indicated by the AxB mean squared.

Study 2

Factor A: $F(2,72) = 9.602$

$F_{cv(.05)} = 3.15$

$F_{cv(.01)} = 4.98$

Because F_{obt} for factor A exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant main effect of factor A.

Factor B: $F(3,72) = 9.602$

$F_{cv(.05)} = 2.76$

$F_{cv(.01)} = 4.13$

Because F_{obt} for factor B exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant main effect of factor B.

AxB: $F(6,72) = 12.002$

$F_{cv(.05)} = 2.25$

$F_{cv(.01)} = 3.12$

Because F_{obt} for the interaction term (AxB) exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant interaction effect.

~~d.~~

Source	Df	SS	MS	F
A	1	10	10	6.002
B	1	60	60	36.014
A x B	1	20	20	12.004
Error	36	60	1.666	
TOTAL	39	150		N=40

a. What is the factorial notation? 2 x 2

b. How many conditions were in the study? 4

c. How many subjects were in the study? 40

d. Identify significant main effects and interaction effects. There is a significant effect on source B. There is little to no significant [2]effect on the intersection of AxB.

Study 3

Factor A: $F(1,36) = 5.99$

$F_{cv(.05)} = 4.17$

$F_{cv(.01)} = 7.56$

Because F_{obt} for factor A exceeds the values for $F_{cv(.05)}$, but is less than $F_{cv(.01)}$, so it is significant at the .05 level. This means that there was a significant main effect of factor A.

Factor B: $F(1,36) = 35.993$

$F_{cv(.05)} = 4.17$

$F_{cv(.01)} = 7.56$

Because F_{obt} for factor B exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant main effect of factor B.

AxB: $F(1,36) = 11.998$

$F_{cv(.05)} = 4.17$

$F_{cv(.01)} = 7.56$

Because F_{obt} for the interaction term (AxB) exceeds both of the values for F_{cv}, it is significant at the .01 level. This means that there was a significant interaction effect.

- Question 12. A researcher is attempting to determine the effects of practice and gender on a timed task. Participants in an experiment are given a computerized search task. They search a computer screen of various characters and attempt to find a particular character on each trial. When they find the designated character, they press a button to stop a timer. Their reaction time (in seconds) on each trial is recorded. Subjects practice for 2, 4, or 6 hours and are either female or male. The reaction time data for the 30 subjects appear here.

2hrs	**Women**	**Men**	**4hrs**	**Women**	**Men**	**6hrs**	**Women**	**Men**	
	12	11		10	8		7	5	
	13	12		10	8		5	6	
	12	13		10	10		7	8	
	11	12		8	10		6	6	
	11	11		7	9		7	8	
total	59	59		45	45		32	33	
mean	**11.8**	**11.8**		**9**	**9**		**6.4**	**6.6**	
Gmean women	**9.06667**		**Gmea nmen**	**9.13333**			**N=30**		

Source	**Df**	**SS**	**MS**	**F**
Gender	1	0.027	0.027	0.022
Practice	2	140.60	70.3	57.764
Gender x Practice	2	0.073	0.036	0.029
Error	23	28	1.217	

TOTAL	29	168.70		

a. Complete the ANOVA summary table. (If your instructor wants you to calculate the sums of squares, use the preceding data to do so.)

b. Are the values of F_{obt} significant at a = .05? At a = .01?
- Gender F_{cv} at .05 alpha is 4.28 and 7.88 at .01 alpha. **0.022<4.28** and **0.022<7.88**. Therefore gender is not significant.
- Practice F_{cv} at .05 is 3.42 and 5.66 at .01 alpha. 57.764>3.42 and 57.764>5.66. Therefore, practice is significant at alpha .05 and .01.

Gender x Practice: $F(2,24) = 0.031$

$F_{cv(.05)} = 3.40$

$F_{cv(.01)} = 5.61$

Because F_{obt} for interaction term (Gender x Practice) is less than both of the values for F_{cv}, it is not significant.

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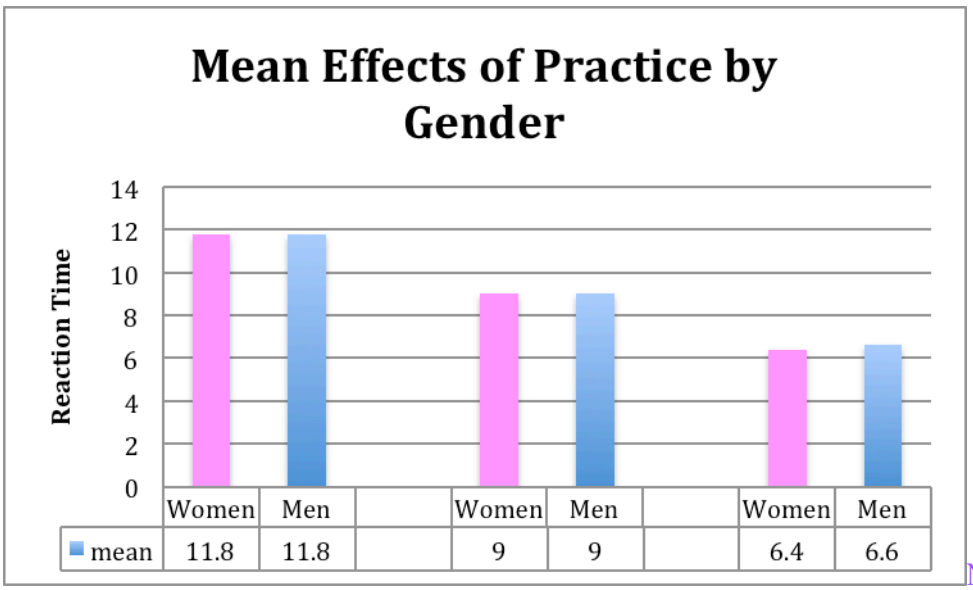
c. What conclusions can be drawn from the F-ratios? Gender is not significant at alpha .05 and .01 however, practice is significant at alpha levels .05 and .01. The interaction of gender and practice time does not affect reaction time.

d. What is the effect size, and what does this mean? The effect size of the 2hr and 4hr group was 0 and the effect size of the 6hr group was 0.87735631, which is 88% effect. The effect size between genders indicated that there was only a .0226 or 2.26% effect.

e. Graph the means.



Nice work on the graph.

2. Explain the difference between multiple independent variables and multiple levels of independent variables. Which is better?

3. What is blocking and how does it reduce "noise"? Blocking is a research design, which is equivalent to a random sampling design (Trochim, 2006). Randomized block designs are designed to reduce variance in the data (Trochim, 2006). Blocking helps to improve precision by raising homogeneity of response among the subjects comprising the block. What is a disadvantage of blocking? One disadvantage to a block design is that all blocks must be homogeneous. If the blocks are not homogeneous using a block design will not be effective, "ultimately the decision to block involves judgment on the part of the researcher" (Trochim, 2006, para. 3). This blocking design can decrease the reliability of the research if the researcher does not estimate the block sizes correctly.

4. What is a factor? A factor is a major independent variable and is simply a categorical variable with two or more values, referred to as levels (Trochim, 2006). How can the use of factors benefit a design? Using factors in a factorial design helps the researcher organize the variables and levels that will be analyzed using multiple statistics.

One benefit of using factorial designs is that they allow the researcher to assess how variables (factors) interact (Jackson, 2012). In the real world (as opposed to the experimental world), it would be unusual to find that a particular behavior is produced by only one variable; behavior is usually contingent upon many variables (factors) operating together in an interactive way (Jackson, 2012). The use of factors can benefit experimental design by allowing researchers to design experiments with more than one independent variable which allows the researchers to assess how multiple variables (factors) may affect behavior (Jackson, 2012).

5. Explain main effects and interaction effects. A main effect is an outcome that indicates significant difference between levels of a factor or independent variable. Interaction effects are a result of combining levels within factorial designs. These combinations enable researchers to examine the interaction effects that exist between factors (Trochim, 2006). An interaction effect only exists when there is an evident difference on one factor, not levels (Trochim, 2006).

Main effect is an outcome that is a consistent difference between levels of a factor. In other words, main effect is an effect of a single independent variable. There can be as many main effects as there are independent variables. Main effects depict the consequences of a single independent variable in isolation from other independent variables in a factorial design (Trochim & Donnelly, 2008).

Interaction effect is an effect that occurs when differences on one factor depend on which level you are on another factor (Trochim & Donnelly, 2008). In other words, an interaction effect is the effect of each independent variable across the levels of the other independent variable.

Interaction is between factors, not levels (Trochim & Donnelly, 2008).

~~5.~~

6. How does a covariate reduce noise? The basis of a covariance design is a pretest-posttest randomized experimental design (Trochim, 2006). Essentially covariates are independent variables that are adjusted within a study. A covariate is a statistical adjustment, which is based on its relationship with another variable. Good! The covariate reduces noise by reducing variability while maintaining the difference between each group (Trochim, 2006).

~~6.~~ Covariates are variables the researcher adjusts in a study (Trochim & Donnelly, 2008). The covariate is used to make statistical adjustments (subtracting out a relationship) that attempt to control important factors in a study (Alton, Pearl, Bateman, McNab, & Berke, 2013; Trochim & Donnelly, 2008). The analysis of covariance design (ANCOVA) is a noise-reducing experimental design. It adjusts posttest scores for variability on the covariate (pretest); this is what it means to adjust for effects of one variable on another (Alton et al., 2013; Trochim & Donnelly, 2008). Any continuous variable can be used as a covariate. The pretest is usually the variable that is used because the pretest is the variable that is most highly correlated with the posttest (Alton et al., 2013). The ANCOVA design reduces noise while attempting to keep the signal at its original strength (Alton et al., 2013; Trochim & Donnelly, 2008).

7. Describe and explain three trade-offs present in experiments. In behavioral research, one trade-off to the experimental design is the inability to control the variables, which are likely to affect study outcomes (Cozby, 2009). Even when the purpose of the study is to assess the influences these variables have on other factors within the study, the logistical concerns constrain most experimental frameworks (Cozby, 2009). Another trade-off to the experimental design is a technique designed to homogeneously equate the groups from the start of the study (Trochim & Donnelly, 2008). However, there are no guarantees that these groups are equated. The fact that the groups are homogeneous constitutes an important source of random error. It is more difficult to identify variability in the research data due to the independent variable when random error is present (Jackson, 2012). Limitations to randomly assigning subjects to particular groups bring a third trade-off to the experimental study. It is sometimes unrealistic to randomly assign subjects to educational experiments. The inability to randomly assign subjects, often leads the researcher to use quasi-experimental designs (Cresswell, 2009). The programs studied under quasi-experimental design often are dynamic, constantly changing, and almost always unstandardized (Cresswell, 2009). You identify some of the major hurdles with the experimental designs.

References

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Cresswell, J.W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches, 3rd edition.* Thousands Oaks, CA: Sage Publications Inc.

Jackson, S. L. (2012). *Research methods and statistics: A critical thinking approach*. Belmont, CA: Wadsworth Cengage Learning.

Trochim, William M. (October 20, 2006). The research methods knowledge base, 2nd edition. Retrieved from http://www.socialresearchmethods.net/kb/expequi.php

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